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DIVISION OF ENGINEERING SERVICES
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METHOD FOR TESTING EPOXY RESIN ADHESIVES, BINDERS, AND SEALANTS

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Part 9 of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

SCOPE

The procedures used for testing epoxy resin adhesives, binders, and sealants are described in this test method.

This test method is divided into the following parts:

1. Gel Time
2. Bond Strength to Concrete
3. Tensile Adhesion and Cohesion
4. Brookfield Viscosity
5. Slant Shear Strength
6. Sag
7. Tensile Strength and Elongation
8. Other Tests
9. Safety and Health

PART 1. GEL TIME

A. APPARATUS

1. Unwaxed paper cups, approximately 8 oz and 2 oz.
2. Wooden tongue depressor with ends cut square.

3. Stainless steel spatula with a blade 6 inches in length by 1-inch width, with end cut square.
4. A stopwatch accurate to within 1 s, or smaller division.

B. PROCEDURE

1. Condition A and B components in air to $25 \pm 1^\circ\text{C}$.
2. Stir the separate components vigorously with the spatula to re-disperse any settled material.
3. Using 2 oz cups, measure components A and B in the proportions recommended by the manufacturer into an 8 oz paper cup.
4. Start a stopwatch immediately and mix the components for 60 s using a wooden tongue depressor and taking care to scrape the sides and bottom of the cup periodically.
5. Probe the mixture once with the tongue depressor every 30 s.
6. The time at which a soft stringy mass forms in the container is the gel time.

PART 2. BOND STRENGTH TO CONCRETE

A. APPARATUS

1. Concrete blocks 7 by 3 ½ by 2 inches, made from the following formula:

7.9 kg of portland cement

3.5 kg of water

17 kg of commercial quality PCC aggregate, saturated surface-dry, maximum size of 3/8 inch.

17 kg of sand, saturated surface-dry
2. A suitable test apparatus with a load capacity of 2000 pounds force or greater.
3. A sandblasted, 2-inch diameter, threaded steel or aluminum rod may be used in place of the pipe cap.
4. A stopwatch accurate to within 1 s, or smaller division.

B. PROCEDURE FOR EPOXY ADHESIVES

1. Condition the test equipment, materials, and epoxy components for 24 hr at the testing temperature specified.
2. Stir the separate components vigorously for 30 s.
3. Mix the epoxy in the specified volume or weight ratio for 60 s.
4. Immediately start timing.
5. Place the adhesive on the pipe cap, or rod, and the concrete surface.
6. Press pipe cap, or rod, firmly in place and remove the excess adhesive.
7. Just before the required test time, insert the hook into the cap (or rod).
8. The sample should be tested at a separation rate of 0.2 inches/min.

PART 3. TENSILE ADHESION AND COHESION

A. APPARATUS

1. Ceramic markers and Retroreflective pavement markers from the Prequalified and Tested Delineator Materials list, three each per test.
2. Use testing apparatus described in Part 2, A. 2 of this test method.
3. Cold box capable of maintaining $-9 \pm 1^{\circ}\text{C}$.
4. Oven capable of maintaining $60 \pm 1^{\circ}\text{C}$.

B. PROCEDURE

1. Stir the separate components vigorously for 30 s.
2. Mix the epoxy in the proper ratio specified by the manufacturer.
3. Prepare test specimens by placing the adhesive on the pipe cap or rod and the surface to be tested.
4. Press the pipe cap or rod firmly in place and remove the excessive adhesive.
5. Cure all specimens for 24 hr at $25 \pm 1^{\circ}\text{C}$.
6. Determine the tensile strength according to Part 2, B of this test method. Test in triplicate.
7. Post cure one ceramic marker test specimen further as follows:
 - a. 48 hr at 60°C .
 - b. Cool to $25 \pm 1^{\circ}\text{C}$, and then place in cold box for 24 hr at $-9 \pm 1^{\circ}\text{C}$.
 - c. Return to $25 \pm 1^{\circ}\text{C}$ and test as in Step No. 6 above.

PART 4. BROOKFIELD VISCOSITY

A. APPARATUS

1. Model RVT Brookfield Syncro-Electric Viscometer, Brookfield Engineering Laboratories and the appropriate spindles.
2. Round, pint paint cans.
3. Stainless steel spatula, having a blade 6 inches by 1 inch, with the end cut square.

B. PROCEDURE

1. Condition and mix epoxy components as in the Gel Time procedure (Part 1).
2. Fill a pint can within 1 inch of the top with well-mixed epoxy.
3. Remove entrained air bubbles by vigorous tamping.
4. Insert the proper spindle according to specifications.
5. Measure the viscosity in poise within 10 min of stirring.

PART 5. SLANT SHEAR STRENGTH

A. APPARATUS

1. Ottawa sand, ASTM Designation: C 109
2. Portland cement, Type II
3. Suitable mold to make diagonal concrete mortar blocks with a 2-inch square base and having one diagonal face 2 by 4 inches, starting about $\frac{3}{4}$ inch above the base. The diagonal faces of two such blocks are bonded together, producing a block of dimensions 2 by 2 by 5 inches.
4. Blocks made from the following composition:

- a. Ottawa sand, ASTM Designation: C 109, 13.65 kg
 - b. Portland cement, Type II, 5.49 kg
 - c. Water, 2.185 L
 - d. Cure blocks 28 days in a fog room
 - e. Dry and sandblast diagonal faces
5. Suitable test press.

B. PROCEDURE

1. Mix the epoxy, as described in Part 1 of this test method, and apply a coat to each diagonal surface. Press diagonal surfaces of each block together by hand and remove excess epoxy adhesive.
2. Align the blocks so that the ends and sides are square and form a block 2 by 2 by 5 inches. Use blocks of wood or metal against each 2 square inch end to keep diagonal faces from slipping until epoxy hardens.
3. After the specified cure time, apply a suitable capping compound to each of the 2 inch square bases and test by applying a compression load with a Universal Test Machine or other suitable testing apparatus at the rate of 5000 lbs/min until failure.
4. Report results in psi.
5. For wet shear strength, bond another set of blocks together as described above. Cure 24 hr at $25 \pm 1^\circ\text{C}$; then soak in water for seven days at $25 \pm 1^\circ\text{C}$, and immediately test as described above in number 3.

PART 6. SAG TEST

A. APPARATUS

1. Unwaxed paper cups, approximately 8 oz and 2 oz.

3. Wooden tongue depressor with ends cut square.
4. Stainless steel spatula with blade, 6 by 1 inches with the end cut square.
5. Leneta chart, Form 2-A Opacity.
6. Metal shims, $\frac{1}{4}$ inch thick, and at least 7 inches in length.
7. Metal straightedge, 6 inches in length.
4. Plate glass: $\frac{1}{4}$ inch thick, 8-inches wide and 11-inches long.
5. Air circulation oven capable of maintaining $70 \pm 0.5^{\circ}\text{C}$.
6. The centrifuge shall be capable of maintaining 2000 rpm, with cups having a capacity of approximately 150-mL each.

B. PROCEDURE

1. Place the shims on the glazed face of Leneta chart to outline an area 2.5 inches wide by 7 inches long.
2. Condition and mix epoxy components as in the Gel Time procedure (Part 1).
3. Place mixed epoxy near one end of the chart, between the shims. Use metal straightedge to draw down a sheet 7 inches long by 2.5 inches wide by $\frac{1}{4}$ inch thick.
4. Remove the shims and immediately hang chart vertically, with 7-inch edges at top and bottom, until the epoxy hardens.
5. Epoxy should not sag or flow down the chart. The edges should remain straight.

PART 7. TENSILE STRENGTH AND ELONGATION

A. APPARATUS

1. Leveling table, 12 by 15 inches, about $\frac{1}{2}$ inches thick, with the surface milled flat and smooth.
2. Cut two pieces of Mylar about 8 by 12 inches each.
3. Milled and polished steel gasket with outside dimensions 8 by 11 inches, and inside dimensions 6.5 by 9.5-inches. The thickness shall be milled to 0.125 inches.
1. Level the table using adjusting screws and a suitable bubble level.
2. Cut two pieces of Mylar about 8 inches by 12 inches each.
3. Place one piece of Mylar on surface of the leveling table and place steel gasket over the Mylar sheet.
4. Mix the epoxy in the specified volume or weight ratio.
5. Place centrifuge tubes on each pan of a suitable torsion balance. Pour mixed epoxy into each tube until tubes are balanced.
6. Immediately place tubes in centrifuge and spin at 2000 rpm for 3 minutes to remove air bubbles.
7. Remove tubes from centrifuge and pour epoxy into steel gasket, spreading out the epoxy as evenly as possible within the gasket and slightly thicker than the gasket.
8. Roll up the second piece of Mylar sheet, and starting at one edge of the steel gasket, carefully unroll the Mylar sheet over the epoxy, taking care not to trap any air pockets between the epoxy surface and the Mylar sheet.
9. Place flat plate glass over the Mylar sheet and push down hard to extrude excess epoxy from edges of steel gasket.

10. Place a suitable weight on top of glass plate to keep an even pressure on the epoxy sheet.
11. Cure the specimen for 18 hr at 25°C.
12. Strip epoxy sheet from Mylar and gasket and place in oven for 5 hr at 70°C.
13. Cool to 25°C and cut test specimens with die shown in Figure 1.
14. Proceed as in ASTM Designation: D 638, using a 0.2-inch per minute-press rate and a 1-inch gage length.

PART 8. OTHER TESTS

A. DUROMETER HARDNESS AT 25°C, TYPE D

Use the procedure as specified in ASTM Designation: D 2240.

B. DENSITY (g/mL)

Use the procedure as specified in ASTM Designation: D 1475.

PART 9. SAFETY AND HEALTH

This method may involve hazardous materials, operations, and equipment. This method does not purport to address all the safety problems associated with its use. It is the responsibility of whoever uses this method to consult and establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

Epoxy resins contain irritants, especially to the skin, eyes, and respiratory system. Persons handling these materials shall use appropriate protective clothing, including rubber or plastic gloves. If any epoxy resin should contact the skin, it shall be removed immediately with a dry cloth or paper towel, and the area of contact washed thoroughly with soap and water. Solvents shall *not* be used, because they carry the irritant into the skin. Cured epoxy resins are innocuous.

Prior to handling testing or disposing of any materials, testers are required to read the

Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCES

ASTM Designations: C 109, D 638, D 1475, and D 2240

End of Text

(California Test 434 contains 6 pages)

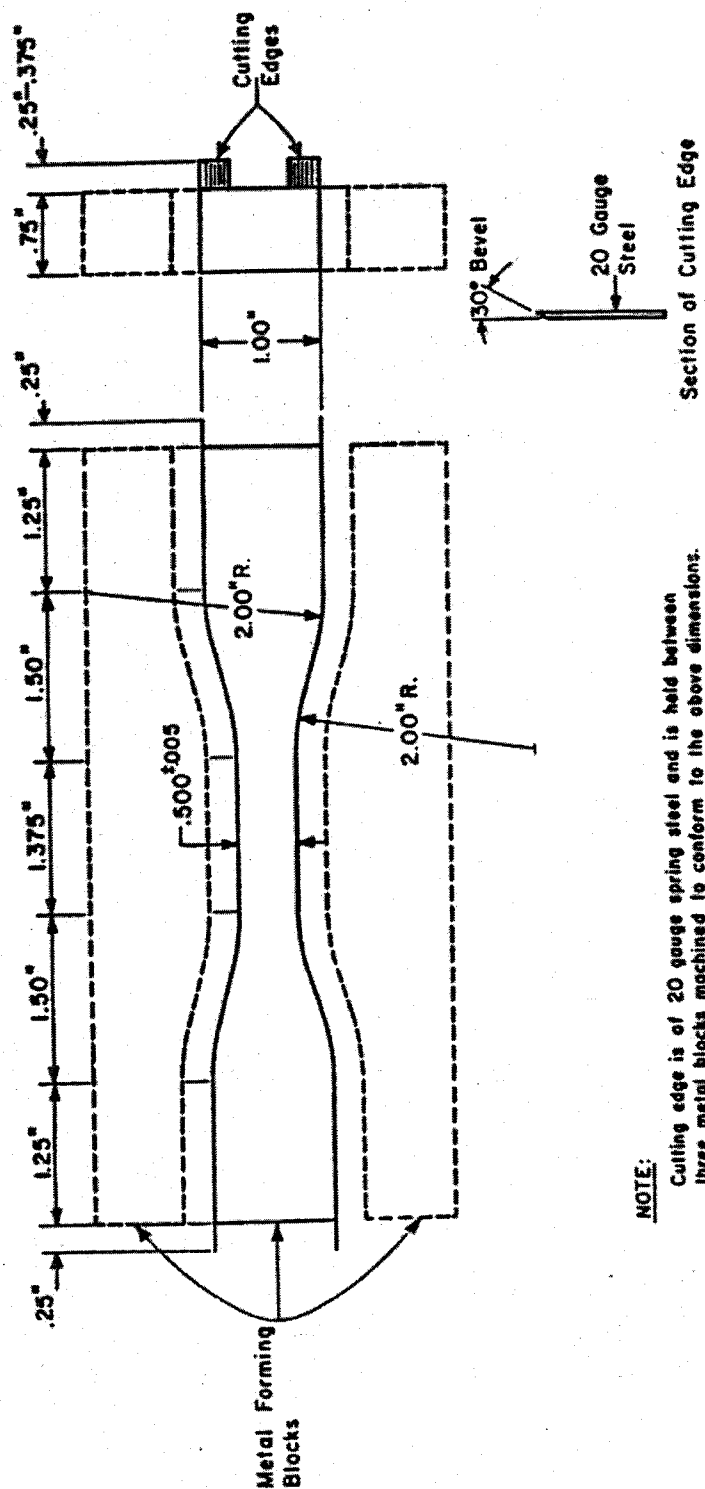


FIGURE 1 - CUTTING DIE FOR TENSILE TESTING